DEPARTAMENTO DE RECURSOS HUMANOS
ASUNTO: Constancia de servicios

A QUIEN CORRESPONDA:
P R E S E N T E.-

El que suscribe Jefe del Departamento de Recursos Humanos del Instituto Tecnológico de Durango, por este conducto hace ***CONSTAR*** que de acuerdo a la documentación existente en los archivos del Depto. de Recursos Humanos, el **C. GALLEGOS INFANTE JOSE ALBERTO**, con R.F.C. GAIA670408868 clave presupuestal 1402E3863000141072, Profesor Investigador de Carrera Titular "C", con estatus (10), su fecha de ingreso al S.N.I.T. el 01 de Abril de 2000, cuenta con 16 años de servicio no ha sido acreedor a ningún tipo de sanción y cumplió con el 90% de su jornada y horario de trabajo durante el período a evaluar 2016.

Se extiende la presente a petición para los fines legales a que hubiere lugar, en la ciudad de Durango, Dgo., a 2 de agosto de 2017.

ATENTAMENTE.

INSTITUTO TECNOLÓGICO de Durango
RECURSOS HUMANOS

ING. JUAN VANEGAS RENTERIA
JEFE DEL DEPARTAMENTO DE RECURSOS HUAMANOS

JVR/aice

5.3 Nivel II SNI

CONACYT
SNI
Sistema Nacional de Investigadores

El Sistema Nacional de Investigadores otorga al

DR. JOSE ALBERTO GALLEGOS INFANTE

la distinción de

INVESTIGADOR NACIONAL NIVEL II

INSTITUTO TECNOLÓGICO DE DURANGO
Vo. Bo.
Ing. Jesus Astorga Perez
Director

SEP INSTITUTO TECNOLÓGICO de Durango
DIRECCIÓN

Durante el periodo del 1 de enero de 2014 al 31 de diciembre de 2018 en virtud de sus logros en la realización de investigación original, reconocida, apreciable y de manera consistente, así como en la formación de recursos humanos para la investigación.

DRA. JULIA TAGÜEÑA PARGA
Secretaria Ejecutiva del SNI

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Documento firmado electrónicamente.
12 de diciembre de 2013

copia fiel del original
Jose Alberto Gallegos Infante

"2015, Año del Generalísimo José María Morelos y Pavón"

México, D. F., 21 de Julio de 2015
Oficio No. DSA/103.5/15/8557

Gallegos Infante Jose Alberto
Instituto Tecnológico de Durango
Presente

Me complace informarle que el Comité Evaluador externo al PRODEP, de acuerdo con las Convocatorias 2015, resolvió positivamente su solicitud de Reconocimiento a Perfil Deseable.

En consecuencia, la SES acredita que usted tiene el perfil deseable para profesores de tiempo completo.

La acreditación tiene validez por 3 años a partir de esta fecha y servirá para los fines establecidos en la propia convocatoria, en el entendido de que dejar de laborar en esta institución conlleva la cancelación del reconocimiento.

Sin otro particular, aprovecho la oportunidad para enviarle un saludo.

Atentamente

M. en C. Guillermina Urbano Vidales

Directora

Calle Vicente García Torres # 235, Col. El Rosedal, Delegación Coyoacán, Distrito Federal, CP. 04330,
Tel. (55) 3601 1000 Extensión: 65934 http://dsa.sep.gob.mx

SECRETARÍA DE EDUCACIÓN PÚBLICA
DIRECCIÓN GENERAL DE PROFESIONES

CÉDULA 6627353

EN VIRTUD DE QUE

JOSE ALBERTO
GALLEGOS
INFANTE

CURP: GAIA670408HSPLNL08

CUMPLIÓ CON LOS REQUISITOS EXIGIDOS POR LA LEY REGLAMENTARIA DEL ARTÍCULO 5o CONSTITUCIONAL RELATIVO AL EJERCICIO DE LAS PROFESIONES EN EL DISTRITO FEDERAL Y SU REGLAMENTO, SE LE EXPIDE

EN EDUCACIÓN DE TIPO SUPERIOR LA

CÉDULA

PERSONAL CON EFECTOS DE PATENTE PARA EJERCER PROFESIONALMENTE EN EL NIVEL DE

DOCTORADO EN
CIENCIAS DE LOS ALIMENTOS

VÍCTOR EVERARDO BELTRÁN CORONA
DIRECTOR GENERAL DE PROFESIONES

Es copia fiel del original

Jose Alberto Gallegos Infante

México, D.F., 09 de Abril del 2015
Oficio Nº DSA/103.5/15/2779

Integrantes
José Alberto Gallegos Infante
Martha Roció Moreno Jiménez
Nuria Elizabeth Rocha Guzmán
Rubén Francisco González Laredo

Instituto Tecnológico de Durango
Presentes

Me complace informarles que el Comité Evaluador externo al Programa, de acuerdo con lo establecido en las Reglas de Operación 2014, ha dictaminado que el Cuerpo Académico "**Alimentos funcionales y nutracéuticos**" con clave **ITDUR-CA-5** se encuentra **CONSOLIDADO**.

En consecuencia, la Subsecretaría de Educación Superior (SES), a través de este Programa, acredita el registro de este Cuerpo Académico por **5** años a partir de esta fecha, por lo que será evaluado nuevamente en el año **2020** o cuando le sea requerido por la Dirección de Superación Académica con el propósito de valorar los avances en su desarrollo.

Sin otro particular, aprovecho la oportunidad para reiterarle la seguridad de mis más distinguidas consideraciones.

A t e n t a m e n t e

M. en C. Guillermina Urbano Vidales
Directora

Ciudad de México, 25 de Noviembre de 2016
Oficio No. DSA/103.5/16/15091

Ing. Mecán Pérez Jesús Astorga
Director
Instituto Tecnológico de Durango
Presente

Acerca del informe de resultados del tercer año presentado por la red temática de colaboración académica aprobada en el marco de la convocatoria 2011, le informo el resultado del proyecto en el que participa un cuerpo académico de su Institución:

I. Red con informe aprobado:

Nombre de la Red	Cuerpo Académico iniciador	Integrantes	Institución de los Integrantes
Nanotecnología y Omics para el Estudio de Nutracéuticos	ITDUR-CA-5 - Alimentos Funcionales y Nutracéuticos	Calidad, Seguridad y Bioactividad de Alimentos Vegetales (Responsable:ITDUR-CA-5)	Centro de Edafología y Biología Aplicada del Segura - CSIC
		ITCEL-CA-2 - Biotecnología Molecular	Instituto Tecnológico de Celaya
		Grupo de Investigación en Metabolismo, Microbiota Intestinal y Salud (Responsable:ITCEL-CA-2)	Universidad Europea de Madrid, España
		Reologia y Nanomateriales de Liberación Controlada (Responsable:ITDUR-CA-5)	Universidad Nacional Autónoma de México, México

II. Grupos de investigación externos al PRODEP que se encuentran bajo la responsabilidad del cuerpo académico de su Institución:

Nombre de la Red	Cuerpo Académico responsable de las actividades del grupo de investigación externo	Grupo de investigación externo	Institución
Nanotecnología y Omics para el Estudio de Nutracéuticos	ITDUR-CA-5 - Alimentos funcionales y nutracéuticos	Calidad, Seguridad y Bioactividad de Alimentos Vegetales	Centro de Edafología y Biología Aplicada del Segura - CSIC
		Reología y Nanomateriales de Liberación Controlada	Universidad Nacional Autónoma de México, México

El dictamen y el acuse que debe firmar el responsable del cuerpo académico han sido enviados por correo electrónico al Representante Institucional con la solicitud de que el acuse se entregue en esta Dirección a más tardar el **24 de enero de 2017**.

Por último, le comento que para finalizar el compromiso adquirido por el cuerpo académico es necesario que se envíe a esta Dirección, a más tardar el 24 de febrero de 2017, el reporte financiero sobre el ejercicio de los recursos recibidos. Este reporte debe entregarse desglosado por cada uno de los tres años de apoyo y de acuerdo con los rubros y montos autorizados, tanto para el cuerpo académico de su Institución como para los grupos de investigación externos que hayan tenido a su cargo.

Sin otro particular, aprovecho la oportunidad para reiterarle la seguridad de mis más distinguidas consideraciones.

Atentamente

M. en C. María de Jesús Guillermina Urbano Vidales
Directora

C.c.p. **Mtro. Manuel Quintero Quintero**, Director General del Tecnológico Nacional de México. Presente.
C.c.p. **L.E. Rosario Otilia Salazar Herrera**, Representante Institucional ante el Programa. Para su conocimiento.

MJGUV/MEGR/PRR

RED NACIONAL DE INVESTIGACIÓN, INNOVACIÓN Y DESARROLLO TECNOLÓGICO EN

ALIMENTOS FUNCIONALES Y NUTRACÉUTICOS

CONACYT

La Red de Nacional de Investigación, Innovación y Desarrollo Tecnológico en Alimentos Funcionales y Nutracéuticos "AlFaNutra"

del Consejo Nacional de Ciencia y Tecnología (CONACyT)

hace que constar que el (la):

Dr. José Alberto Gallegos Infante

Es miembro ACTIVO de la Red, como parte del Cuerpo Académico de Alimentos Funcionales y Nutracéuticos del Instituto Tecnológico de Durango, participando en las reuniones generales de trabajo durante el 2014.

Dr. Gustavo Adolfo González-Aguilar

Dr. Aarón Fernando González-Córdova

Coordinadores de la Red AlFaNutra

CIAD

MÉXICO
GOBIERNO DE LA REPÚBLICA

CONACYT
Consejo Nacional de Ciencia y Tecnología

El Consejo Nacional de Ciencia y Tecnología

Otorga la presente

Constancia

al

Dr. José Alberto Gallegos Infante

Como

Integrante de la Comisión de Evaluación de Pertinencia de la

Convocatoria de Proyectos de Desarrollo Científico Para Atender Problemas Nacionales 2015.

Tecnología de los Alimentos

México, D. F., Marzo de 2016

DR. LUIS HUMBERTO FABILA CASTILLO
DIRECTOR DE INVESTIGACIÓN CIENTÍFICA BÁSICA

Dirección Adjunta de Desarrollo Tecnológico e Innovación
Dirección de Innovación

México, D.F. 15 de Febrero de 2016

CONSTANCIA DE PARTICIPACIÓN

El Consejo Nacional de Ciencia y Tecnología, por conducto de la Dirección de Innovación de la Dirección Adjunta de Desarrollo Tecnológico e Innovación, hace constar que:

JOSE ALBERTO GALLEGOS INFANTE

efectuó las siguientes evaluaciones:

Convocatoria 2016 del Programa de Estímulos a la Innovación	**5**
Cierre Técnico de la Convocatoria 2014 del Programa de Estímulos a la Innovación	**4**

Atentamente

M.A.P. Hugo Nicolás Pérez González
Director de Innovación

MÉXICO
PRESIDENCIA DE LA REPÚBLICA

CONACYT
Consejo Nacional de Ciencia y Tecnología

Dirección Adjunta de Posgrado y Becas
Subdirección de Becas al Extranjero

México, D. F., 28 de abril de 2016.

DR. JOSE ALBERTO GALLEGOS INFANTE

El Consejo Nacional de Ciencia y Tecnología expresa a usted su reconocimiento por su colaboración como evaluador en el proceso de selección de los candidatos a cursar estudios de Posgrado en el marco de la convocatoria BECAS AL EXTRANJERO 2016.

Gracias a su colaboración, el CONACYT dispone de sólidos elementos que permitirán que los aspirantes seleccionados con mayores méritos reciban el apoyo solicitado y continúen su formación académica en universidades de prestigio a nivel internacional.

Atentamente

M. en C. Maria Dolores Sánchez Soler
Directora Adjunta

MÉXICO
GOBIERNO DE LA REPÚBLICA

CONACYT
Consejo Nacional de Ciencia y Tecnología

Ciudad de México, mayo de 2017

Dr. José Alberto Gallegos Infante
Instituto Tecnológico de Durango
Presente.

En nombre de la Dirección de Cátedras CONACYT, me permito agradecer y extender nuestro más amplio reconocimiento por su valiosa participación como evaluador en línea de los proyectos sometidos en el marco de la Convocatoria de Cátedras CONACYT 2017.

Su contribución es fundamental para la selección de proyectos a ser beneficiados con Cátedras Conacyt. Es por ello que esperamos contar con su valioso apoyo en futuras ocasiones.

Sin otro particular por el momento, aprovecho la oportunidad para enviarle un cordial saludo.

Atentamente

Mtro. Roberto Rodríguez Rodríguez
Director de Cátedras CONACYT

MÉXICO
PRESIDENCIA DE LA REPÚBLICA

CONACYT
FORDECyT
Fondo Institucional de Fomento Regional para el Desarrollo Científico, Tecnológico y de Innovación

EL FONDO INSTITUCIONAL DE FOMENTO REGIONAL PARA EL DESARROLLO CIENTÍFICO, TECNOLÓGICO Y DE INNOVACIÓN (FORDECYT)

Otorga la presente

CONSTANCIA

a: José Alberto Gallegos Infante

por su valiosa participación como "Evaluador de Propuestas" en el Proceso de Evaluación de Pertinencia Técnica-Financiera de la Convocatoria 2016-01 del FORDECYT; de la demanda 4 "Fortalecimiento de las capacidades científicas y tecnológicas para la identificación, desarrollo y aplicación de ingredientes y/o compuestos funcionales a partir de materias primas naturales"

Mtro. Jorge Antonio Villegas Rodríguez
Secretario Técnico del FORDECYT

México, D.F. a 28 de abril de 2016.

ITESCA
Instituto Tecnológico
Superior de Cajeme

El Instituto Tecnológico Superior de Cajeme

Otorga El presente

Reconocimiento

A

José Alberto Gallegos Infante

Por su invaluable apoyo en la evaluación de los Proyectos de investigación de la **"Convocatoria de Apoyo a la Investigación Científica 2017"** Realizada los días 14 al 18 de Noviembre de 2016

Ciudad Obregón, Sonora a 18 de Noviembre de 2016

LIC. GABRIEL BALDENEBRO PATRON
Director General del Instituto
Tecnológico Superior de Cajeme

OFICIO TPE/034/2016.

Victoria de Durango, Dgo., noviembre 1 de 2016.

DR. JOSÉ ALBERTO GALLEGOS INFANTE
INVESTIGADOR DEL INSTITUTO TECNOLÓGICO
DE DURAGO
P R E S E N T E.

Sea este el conducto, por el cual le comunico que con esta fecha, en mi carácter de Presidente de la Junta Directiva del Consejo de Ciencia y Tecnología del Estado de Durango y en cumplimiento a las facultades que me confiere el artículo 51, último párrafo de la Ley de Ciencia y Tecnología del Estado de Durango, tengo a bien invitarlo a fungir como integrante de la Junta Directiva del Consejo de Ciencia y Tecnología del Estado de Durango, con el carácter de Vocal, lo cual hago de su conocimiento para su atención procedente, y seguro de contar con su colaboración, lo exhorto a participar en dicho Consejo con estricto apego al marco normativo.

A T E N T A M E N T E
EL GOBERNADOR DEL ESTADO DE DURANGO Y
PRESIDENTE DE LA JUNTA DIRECTIVA DEL COLEGIO DE CIENCIA Y
TECNOLOGÍA DEL ESTADO DE DURANGO

DR. JOSÉ ROSAS AISPURO TORRES.

El **Gobierno del Estado de Durango** a través de la **Secretaría de Salud** otorga la presente

Constancia

A:

Villegas Novoa Cecilia, Rocha Guzmán Nuria Elizabeth, Moreno Jiménez Martha Rocío, Gallegos Infante José Alberto, González Laredo Rubén Francisco.

Por haber obtenido **PRIMER LUGAR** con el trabajo: "***EFECTO DE UN EXTRACTO DE SALVILLA (Buddleja scordioides K.) SOBRE LA EXPRESIÓN DIFERENCIAL DE MEDIADORES INFLAMATORIOS INDUCIDOS CON LIPOPOLISACÁRIDO EN CÉLULAS EPITELIALES DE HUMANO"***

en la categoría: *INVESTIGACIÓN EN BIOTECNOLOGÍA E INNOVACIÓN*

en el XV Concurso de Trabajos de Investigación en Salud

realizado en el marco I Jornada Nacional de Investigación en Salud Durango 2017

José Rosas Aispuro Torres

Gobernador del Estado de Durango

Dr. César Humberto Franco Mariscal

Secretario de Salud y Dir. Gral. de los Servicios de Salud

Victoria de Durango, Dgo. a Agosto de 2017

El **Gobierno del Estado de Durango** a través de la **Secretaría de Salud** otorga la presente

Constancia

A:

Reyna-Rojas, J.A., Moreno-Jimenez, M.R., Rocha-Guzmán, N.E., Gallegos-Infante, J.A., Gonzalez-Laredo, R.F., y Rojas-Contreras, J.A.

Por haber obtenido **SEGUNDO LUGAR** con el trabajo: "***POTENCIAL PREBIÓTICO DE FRIJOL (Phaseolus vulgaris L.) BAYO VICTORIA PROCESADO"***

en la categoría: *INVESTIGACIÓN EN BIOTECNOLOGÍA E INNOVACIÓN*

en el XV Concurso de Trabajos de Investigación en Salud

realizado en el marco I Jornada Nacional de Investigación en Salud Durango 2017

José Rosas Aispuro Torres

Gobernador del Estado de Durango

Dr. César Humberto Franco Mariscal

Secretario de Salud y Dir. Gral. de los Servicios de Salud

Victoria de Durango, Dgo. a Agosto de 2017

El **Gobierno del Estado de Durango** a través de la **Secretaría de Salud** otorga la presente

Constancia

A:

Julio C Ramírez-España, Nuria E. Rocha-Guzmán, Rubén F. González-Laredo Alberto Gallegos-Infante. Claudia I. Gamboa-Gómez

Por haber obtenido **TERCER LUGAR** con el trabajo: "***Biodisponibilidad y actividad antioxidante de compuestos fenólicos de bebidas vegetales de hojas de encino fermentadas con hongo kombucha"***

en la categoría: *INVESTIGACIÓN EN BIOTECNOLOGÍA E INNOVACIÓN*

en el XV Concurso de Trabajos de Investigación en Salud

realizado en el marco I Jornada Nacional de Investigación en Salud Durango 2017

José Rosas Aispuro Torres

Gobernador del Estado de Durango

Dr. César Humberto Franco Mariscal

Secretario de Salud y Dir. Gral. de los Servicios de Salud

Victoria de Durango, Dgo. a Agosto de 2017

DURANGO
GOBIERNO DEL ESTADO

EL GOBIERNO ESTADO DE DURANGO

Y LA SECRETARÍA DE EDUCACIÓN DEL ESTADO

A TRAVÉS DEL

CONSEJO DE CIENCIA Y TECNOLOGÍA DEL ESTADO DE DURANGO

DURANGO
Consejo de Ciencia y Tecnología

Otorgan el presente

RECONOCIMIENTO

A: Dra. Nuria Elizabeth Rocha Guzmán
Dr. José Alberto Gallegos Infante
Dr. Rubén Francisco González Laredo
Dra. Martha Rocío Moreno Jiménez
Dr. Luis Medina Torres

PREMIO ESTATAL DE CIENCIA, TECNOLOGÍA E INNOVACIÓN DURANGO 2015

EN EL ÁREA DE:

INGENIERÍAS, DESARROLLO INDUSTRIAL Y TECNOLÓGICO

CON EL TRABAJO DE INVESTIGACIÓN:

Desarrollo tecnológico para obtener nanopartículas bioactivas de poli-(DLLactida- Co-Glicolida) cargadas con lupeol de hojas de encino

Victoria de Durango, Dgo. Noviembre de 2015

ING. HECTOR E. VELA VALENZUELA
Secretario de Educación
del Estado de Durango

C.P. JORGE HERRERA CALDERA
Gobernador Constitucional del Estado de Durango

DR. ELISEO MEDINA ELIZONDO
Director General del Consejo de Ciencia
y Tecnología del Estado de Durango

EL GOBIERNO DEL ESTADO DE DURANGO Y LA SECRETARÍA DE EDUCACIÓN A TRAVÉS DEL CONSEJO DE CIENCIA Y TECNOLOGÍA DEL ESTADO DE DURANGO

DURANGO
GOBIERNO DEL ESTADO

Unidos crecemos en ciencia, tecnología e innovación

CONSEJO DE CIENCIA Y TECNOLOGÍA DEL ESTADO DE DURANGO
COCYTED
1996
CIENCIA Y TECNOLOGÍA

Otorgan el presente

RECONOCIMIENTO

A: *Dra. Martha Rosales Castro, Dra. Nuria Elizabeth Rocha Guzmán, Dr. Rubén Francisco González Laredo y Dr. José Alberto Gallegos Infante*

POR HABER SIDO MERECEDORES DEL PREMIO ESTATAL DE "CIENCIA, TECNOLOGÍA E INNOVACIÓN DURANGO 2012", EN EL ÁREA DE:

CIENCIAS EXACTAS E INGENIERÍA

COLABORANDO A LA VINCULACIÓN DE LA CIENCIA, TECNOLOGÍA E INNOVACIÓN EN PROYECTOS QUE HAN CONTRIBUIDO A ELEVAR EL DESARROLLO ACADÉMICO, CIENTÍFICO Y EMPRESARIAL EN NUESTRO ESTADO.

Victoria de Durango, Dgo. Octubre 2012

ING. HECTOR VELA VALENZUELA
Secretario de Educación
del Estado de Durango

C.P. JORGE HERRERA CALDERA
Gobernador Constitucional del Estado de Durango

DR. JOSÉ DIMAS LÓPEZ MARTÍNEZ
Director General del Consejo de Ciencia
y Tecnología del Estado de Durango

Universidad de Sonora

División de Ciencias Biológicas y de la Salud

Departamento de Investigación y Posgrado en Alimentos

otorga el presente **Reconocimiento** a:

Jacobo Valenzuela, N.

por haber obtenidó el PRIMER LUGAR categoría CARTEL ESTUDIANTIL, con el trabajo:

Efecto del procesamiento sobre compuestos polifenólicos y actividad antioxidante en harinas extrudidas de calabaza (*Cucurbita moschata* D.) cv Cehualca

en colaboración con: Zazueta-Morales, J.J., Gallegos-Infante, J.A., Aguilar-Palazuelos, E., Delgado-Nieblas, C.I., Ordorica-Falomir, C.A., Camacho-Hernández, I.L., Rocha-Guzmán, N. E. y Maróstica-Junior, M.R.

dentro del **VIII Congreso del Noroeste y IV Nacional en Ciencias Alimentarias y Biotecnología**, llevado a cabo del 27 de febrero al 1 de marzo de 2013, en San Carlos, Nuevo Guaymas, Sonora, México.

Dr. Mario O. Cortez Rocha
Director de la División de Ciencias Biológicas y de la Salud

Dr. Armando Burgos Hernández
Presidente del Comité Organizador

27 de febrero al 1 de marzo de 2013. San Carlos, Nuevo Guaymas, Sonora, México.

ASOCIACIÓN MEXICANA DE CIENCIA DE ALIMENTOS

CERTIFICADO DE MEMBRESÍA

El presente documento acredita que:

Dr. José A. Gallegos Infante

forma parte de la asociación en el período de octubre del 2016 a octubre del 2018 en calidad de

MIEMBRO ACTIVO

AMECA

Dr. J. Hugo Sergio García Galindo
(Presidente)

Dr. Nicolás Oscar Soto Cruz
(Secretario)

Año del Centenario de la Promulgación de la Constitución Política de los Estados Unidos Mexicanos

Ciudad de México, 17/febrero/2017

OFICIO No. M00/0361/2017

ING. JESÚS ASTORGA PÉREZ
DIRECTOR DEL INSTITUTO TECNOLÓGICO DE DURANGO
PRESENTE

Con referencia a su oficio D.028/17, donde solicita la Comisión al Extranjero a nombre de JOSÉ ALBERTO GALLEGOS INFANTE, me permito comunicarle que dicha comisión ha sido autorizada, de acuerdo con los siguientes datos:

Evento	Estancia de Investigación
Tipo de evento	Estadía
Período de comisión	Del 15 de marzo al 15 de abril 2017
No. de días	32
Lugar de comisión	Nueva Jersey, Estados Unidos de América
Motivo / Justificación	Realizará una estancia de investigación en la Universidad Estatal de Rutgers, Nueva Jersey, en el campus de Douglas, New Brunswick, NJ, EUA.
Cobertura de gastos	Los gastos de traslado, hospedaje y alimentación serán cubiertos por Proyecto CONACyT

No omito mencionar que, el profesor comisionado deberá entregar en su plantel de adscripción un informe de las actividades realizadas al término de dicha comisión.

Aprovecho la oportunidad para enviarle un cordial saludo.

ATENTAMENTE
EXCELENCIA EN EDUCACIÓN TECNOLÓGICA®

MTRO. MANUEL QUINTERO QUINTERO
DIRECTOR GENERAL

SECRETARÍA DE EDUCACIÓN PÚBLICA
TECNOLÓGICO NACIONAL
DE MÉXICO
DIRECCIÓN GENERAL

JOAG/ORCA

Industrial Crops and Products 90 (2016) 1–8

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journal homepage: www.elsevier.com/locate/indcrop

Microencapsulation by spray drying of laurel infusions (Litsea glaucescens) with maltodextrin

L. Medina-Torres[a,*], R. Santiago-Adame[b], F. Calderas[c], J.A. Gallegos-Infante[d], R.F. González-Laredo[d], N.E. Rocha-Guzmán[d], D.M. Núñez-Ramírez[e], M.J. Bernad-Bernad[a], O. Manero[b]

[a] Facultad de Química, Universidad Nacional Autónoma de México, México, D.F., 04510, Mexico
[b] Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, México, D.F., 04510, Mexico
[c] CIATEC, A.C. Omega 201, Fracc. Industrial Delta, CP 37545, León, Guanajuato, Mexico
[d] Instituto Tecnológico de Durango, Felipe Pescador Ote, CP 34080, Durango, Mexico
[e] Facultad de Ciencias Químicas, Universidad Juárez del Estado de Durango (UJED), Avenida Veterinaria, s/n, Circuito Universitario, C.P. 34120, Durango, Mexico

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Microencapsulation
Laurel infusions (*Litsea glauscecens*)
Spray-drying
Rheological properties and release profile

ABSTRACT

The effect of maltodextrin as an encapsulating agent on spray dried (SD) laurel infusions was studied (inlet temperatures: 140, 160 and 180 °C, and feed rate: 8 and 10 mL/min at fixed flow atomization). In the SD samples, the phenolic content (TPC), antioxidant capacity (DPPH*), morphology (SEM), chemical structure (FTIR), rheology properties and release profiles were studied. The results show that laurel infusion had 42.10 (±0.23) mg gallic acid equivalent/g of laurel and EC_{50} of 0.40 (±0.10) mg laurel/mL of DPPH*, the SD microparticles showed defined morphologies. Encapsulation of laurel infusion was achieved with an efficiency of ~70%. The reconstituted SD powders solutions showed a shear-thinning rheological behavior ($n < 1$). The results evidenced that the best conditions for laurel encapsulation by SD were 160 °C inlet temperature and 8 mL/min feed rate.

1. Introduction

Laurel (*Litsea* spp.) is one of the most used spices in the world. These spices are commonly used as food additives, provide flavors, scents, colors and even help in food preservation. It is commonly known as "bay laurel" and it has been reported to impart antimicrobial and antioxidant properties to food. Laurel has been reported to be used as an aid in gastrointestinal disorders, inflammation problems and atherosclerosis (Shan et al., 2007; Cherrat et al., 2014). The laurel spice has been used since ancient times in traditional Chinese medicine (Xie and Yu, 1996). All these benefits are related to the phytochemicals that compose laurel which include polyphenols such as phenolic acids and flavonoids (Kong et al., 2015; Tsai and Lee, 2011). The phenolic compounds (polyphenols) in Laurel spice provide natural antioxidant capacities to trap free radicals and inhibit oxidative processes in the body (Shan et al., 2005). However, polyphenols are extremely labile at ambient conditions (Ultraviolet, radiation, temperature, oxygen, stomach digestion, etc.) which affects their stability and reduce the antioxidant benefits, so that their protection with encapsulation vectors becomes crucial for the preparation of functional food (D'Archivio et al., 2010; Ersus and Yurdagel, 2007; Jafari et al., 2008). The most common microencapsulation process is spray drying (SD), which has proven to be an effective technology in protecting polyphenolic compounds. SD consists in converting water suspensions into powdered microparticles, which are composed of a wall material (shell) and a core (encapsulated material) (Reineccius, 1988). Carbohydrates, such as maltodextrins are one of the main wall materials used as encapsulating materials to protect polyphenolic compounds (Desai and Park, 2005; Ersus and Yurdagel, 2007; Jafari et al., 2008). Maltodextrins are hydrolyzed starch, they have a low cost and possess high water solubility (>75%) and low viscosity in aqueous solutions. Maltodextrins form a coating film minimizing oxygen contact of the encapsulated material (Pourashouri et al., 2014). Microparticles obtained from SD are able to last for longer periods of time and they have been reported to release the encapsulated materials under simulated conditions of the digestive tract (Medina-Torres et al., 2013) SD is the ideal process to achieve mechanical stability of encapsulated polyphenols particles and preserve their bioactivity (Mahdavi et al., 2014; Khazaei et al., 2014). There have been

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Review Article Open Access

Gastroprotective Activities of *Buddleja scordioides*-Role of Polyphenols against Inflammation

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Abstract

Medicinal plants show great interest today because of its multiple physiological effects. They contain a diversity of chemical compounds, phytochemicals, with demonstrated important biological activities. *Buddleja scordioides* Kunth is a plant that shows a wealth of important phytochemicals, which could contribute towards the prevention of various health problems such as gastrointestinal disorders. The main causes of gastrointestinal pathology are mediated by inflammatory processes caused by several factors. *B. scordioides* HBK (KUNTH) is commonly used for the treatment of diarrhea and stomach pain (colic). Several studies shown presence of flavonoids such as rutin, quercetin and quercetrin and kaempferol (also found in *Buddleja* genus). Other isolated compounds include some hidroxicinnamic and hidroxibenzoic acids, verbascosides, siringin, some iridoids, sesquiterpenes and fenilpropanoids. All of them related with anti-inflammatory activity. The present review is an opinion of the state of art anti-inflammatory activity of *B. scordioides* and gastrointestinal disorders.

Keywords: Anti-Inflammation; *Buddleja scordioides*; Gastroprotection; Phytochemicals

Introduction

Medicinal plants show great interest today because of its multiple physiological effects. They contain a diversity of chemical compounds, phytochemicals, with demonstrated important biological activities. These compounds are produced by the secondary metabolism of plants, which have evolved from different biotic or abiotic factors, and used by the plant for defense or survival. However, multiple studies on these compounds have proven beneficial to human health [1].

Phytochemicals have multiple properties such as antioxidant and anti-inflammatory, which can be used as a preventive means to protect against the development of health problems. They may interact with molecules that can inhibit the genesis of this type of pathologies or conversely, interact with biomarkers that enhance the protective capabilities of the organism.

Medicinal properties of many plants are mainly attributed to the presence of flavonoids, but these effects may also be promoted by other organic and inorganic compounds such as coumarins, alkaloids, terpenes, tannins, antioxidant phenolic acids and micronutrients, for example, Cu, Mn and Zn. *Buddleja scordioides* Kunth is a plant that shows a wealth of important phytochemicals, which could contribute towards the prevention of various health problems such as gastrointestinal disorders. Nowadays these diseases have been considered a health problem around the world due to its high incidence.

Gastrointestinal disease and inflammatory response

Gastrointestinal diseases are one of the most common health problems that affect people of all ages and social condition, although the most vulnerable groups are children and the elders.

In Mexico in 2008, the incidence of ulcers, gastritis and duodenitis were larger than the states of Nayarit, Tabasco and Durango (3396.11, 3212.11 and 2193.78 cases per 100,000 population, respectively) [2]. In general, these problems are associated with inflammatory processes, which are part of a non-specific response of tissues that occurs in reaction to any type of injury, which is an immune response to pathogens, damaged, irritating cells, etc. [3].

The main symptoms of inflammatory processes are: Redness, heat, pain and tumor and also these symptoms can cause high cellular metabolism, vasodilatation, and high blood flow [4]. In some diseases the inflammation process under normal conditions is restrictive; it becomes chronic dysfunctions that develop subsequently. In inflammatory processes, it can be distinguished two steps of inflammation: 1) Acute inflammation that is the immediate response to vascular changes, where widespread effects of inflammation mediators cause pain, heat and swelling; these symptoms are usually short-lived. 2) Chronic inflammation is self-prolonged that and can last for weeks, months and even years, and can be developed as a result of recurrent or progressive acute inflammation [5].

The main causes of gastrointestinal pathology are mediated by inflammatory processes caused by invading microorganisms ingested in the diet, use of medications that hurt the mucosa such as non-steroidal anti-inflammatory drugs (NSAIDs), milk and dairy fats, alcohol, stress and nervousness are responsible for many digestive disorders [6]. Their presence of symptoms is varied, may include stomach or abdominal pain accompanied by cramps, diarrhoea, dehydration, abdominal bloating, increased intestinal gas, lawn blood, fever, tires, loss of appetite and weight loss, weakness and constipation, among others [7].

Once developed an inflammatory process focused on the gastrointestinal tract, the mucosa in charge of maintenance and integrity causing activation of immune cells, which begin to produce different proteins (cytokines) by expressing different molecules in

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Effect of pulsed electric field (PEF)-treated kombucha analogues from *Quercus obtusata* infusions on bioactives and microorganisms

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ABSTRACT

Pulsed electric field (PEF) is a promising non-thermal food preservation technology. The objective was to study inactivation of yeasts in PEF-treated kombucha analogues prepared from *Quercus obtusata* infusions. Fermentation conditions of infusions from *Q. obtusata* were time (7 days), sugar (10%), starting culture (10%), and inoculum (2.5%, at 25 °C). The PEF treatment considered using square waves, an electric field strength (37.3–53.4 kV/cm), PEF processing time (445.3–1979.2 μs), an output temperature (18.31 ± 0.98 °C), an input energy (21.2 - 136.5 KJ/L), and two feed flow rates (51.42 and 102.85 L/h). pH, °Brix, color determinations, microbiological testing, total phenolic, flavonoid content, DPPH test, and UPLC/ESI/MS/MS analysis were done. No changes at different PEF conditions were observed for pH and °Brix. Higher color changes were observed at higher specific energies. Acid-acetic bacteria were more sensitive to PEF than yeasts. Lower specific energies render products with higher polyphenolic content and antioxidant capacity.

Industrial relevance: Pulse electric field is an interesting alternative to preserve kombucha analogues from oak leave infusions with minimal changes in physicochemical characteristics, antioxidant activity and bioactive compounds. The present work describes the effect of feed flow and specific energy on the several characteristics of fermented beverages, determining conditions for best processing.

1. Introduction

Thermal treatments are effective on enzyme inactivation and microbiological control. However, they imply an important loss of nutrients and phytochemicals such as phenolic compounds (Manzocco, Mastrocola, & Nicoli, 1998), although several reports have claimed opposite results (Manzocco, Anese, & Nicoli, 1998; Nicoli, Anese, Parpinel, Franceschi, & Lerici, 1997).

The conventional way to determine the efficiency of a thermal process is based on the assumption that survival curves of microbial cells and bacterial spores are governed by a first-order kinetic law (Mafart, Couvert, Gaillard, & Leguerinel, 2002). As a complement to or replacement of traditional thermal pasteurization, pulsed electric field (PEF) is a promising non-thermal food preservation technology (Toepfl, Heinz, & Knorr, 2007). Several investigations have been performed in various fruit juices to evaluate microbial resistance to PEF treatments (Raso, Calderón, Góngora, Barbosa-Cánovas, & Swanson, 1998a, 1998b; Timmermans et al., 2013). Wouters, Alvarez, & Raso (2001) indicate that the main process parameters that affect microbial inactivation by PEF are electric field strength, pulse length, pulse shape, number of pulses, and start temperature (MacGregor, Farish, Fouracre, Rowan, & Anderson, 2000). Also, type of microorganism, species, strains, size and shape are related with the efficiency of PEF to inactivate microorganisms (Wouters et al., 2001).

Electric field strength and treatment time are the most studied parameters related with microbial inactivation by PEF. The main process parameters that affect microbial inactivation by PEF are electric field strength, pulse length, pulse shape, number of pulses, and starting temperature (Barbosa-Canovas, Pothakamury, Gongora-Nieto, & Swanson, 1999; Saldaña, Álvarez, Condón, & Raso, 2014; Siemer, Toepfl, & Heinz, 2014). In general, increasing the intensity of these factors enhances microbial inactivation; however, their relationship with the survival fraction is unclear (Wouters et al., 2001). Not only process parameters are important, but also product parameters are significant too.

PEF treatment has been applied to a range of different products as fruit juices, milk, liquid eggs, and dry herbs (Barba et al., 2015). Also the influence of pH and conductivity has been studied by several groups. Wouters et al. (2001) found that a change in the medium conductivity affected the pulse energy; Vega-Mercado, Pothakamury, Chang, Barbosa-Cánovas, & Swanson (1996), concluded that it is better to

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Spray drying-microencapsulation of cinnamon infusions (*Cinnamomum zeylanicum*) with maltodextrin

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ABSTRACT

The effect of temperature and feed rate on spray dried cinnamon infusions (SDCInf) using maltodextrin as an encapsulating agent was studied (inlet temperature: 140, 160, and 180 °C; feed rate: 8 and 10 mL/min). Total phenolic content (TPC), antioxidant capacity (DPPH*), morphology (SEM), chemical (FTIR) and rheological properties, and releasing profiles were assessed in SDCInf. Cinnamon infusions (CInf) resulted in 29.32 (±0.70) mg of GAE/g of cinnamon. As for DPPH* inhibition, EC_{50} was 0.291 (±0.09) mg of cinnamon/mL. Microparticles showed a deflated-balloon like shape, encapsulating up to ~85% of the cinnamon infusion, and a simple shear-thinning behavior ($n < 1$). Results show that powdered SDCInf obtained at 160 and 180 °C and 10 mL/min yielded the best protection for cinnamon infusions.

1. Introduction

Spices are commonly used food additives. They provide flavor, aroma, color, and food preservative capabilities. Cinnamon is the second most important spice (just behind black pepper) in the USA and Europe (Jayaprakasha, Negi, Jena, & Rao, 2007). Its consumption is related to health benefits, such as: antimicrobial activity, inhibition of cancer cells proliferation, protection against common flu, and glucose control in diabetes (Anderson et al., 2004). Among the compounds related to these effects are polyphenols. Polyphenols possess characteristic properties, such as free-radical scavenging and inhibition of oxidizing processes in the body. Phenolic compounds are important because they provide cinnamon with natural antioxidant capacity (*i.e.* scavenging of free radicals). However, they are extremely sensitive to environmental conditions (e.g. UV radiation, temperature, oxygen, digestion, etc.). Microencapsulation processes, such as spray drying, have proved to be an effective technology for protecting this sort of compounds. This technology turns suspensions into powdered microparticles, comprised of a wall material and a core. Carbohydrates, such as maltodextrins, are among major wall materials; they are used as encapsulating materials that protect the core (Desai & Park, 2005; Jafari, Assadpoor, He, & Bhandari, 2008). Maltodextrins are obtained from starch hydrolysis. They are cheap, highly water soluble (>75%), and aqueous solutions containing them have commonly low viscosity. This material has the ability to form a cover for the core, encapsulating aromas and flavors, minimizing exposure to oxygen (Pourashouri et al., 2014). Microparticles obtained by spray drying are able to protect cores for long periods and release them under digestive conditions. Therefore, this process is suitable for increasing polyphenols stability during long-term storage while preserving their biological activity (Khazaei, Jafari, Ghorbani, & Kakhki, 2014; Mahdavi, Jafari, Ghorbani, & Assadpoor, 2014). Thus, these microparticles are studied in relation to their total phenolic content, chemical configuration (FTIR-analysis), morphology (Scanning Electron Microscopy), particle size homogeneity (Particle Size Distribution, PSD), rheological properties, and release profile. There are several studies on the non-polar fraction of cinnamon, yet only a few for the aqueous fraction. The aim of this study was to assess the effect of temperature and feed rate on the properties of SDCInf encapsulated with maltodextrin in order to find the best spray drying conditions to achieve the highest total

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Elaboration of functional snack foods using raw materials rich in carotenoids and dietary fiber: effects of extrusion processing

Elaboración de alimentos botana funcionales utilizando materias primas ricas en carotenoides y fibra dietaria: efectos del proceso de extrusión

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This research studied the effect of extrusion temperature (ET, 93.45–140.55°C), moisture content (MC, 21.27–34.73%), and the winter squash flour content (WSF, 0.43–15.57%) on physicochemical characteristics and content of bioactive compounds of third-generation (3G) snack foods expanded by microwave heating. The ingredients used for their elaboration were corn starch, whole-grain yellow corn and winter squash flours. A single-screw extruder was employed, and the response surface methodology was applied. The lowest bulk density and the highest water solubility index (WSI) and water absorption index, occurred at high ET with low MC. The highest values of total carotenoids and dietary fiber (total and soluble) were obtained at high WSF and ET. Furthermore, when the WSF was increased, the color L* value diminished, whereas b* value and WSI increased. These results suggest that it is possible to elaborate 3G snack foods with acceptable physicochemical characteristics and excellent bioactive compounds content, improving their potential health benefits.

Keywords: functional snacks; extrusion; third-generation snacks; carotenoids compounds; dietary fiber

Esta investigación estudió el efecto de la temperatura de extrusión (TE, 93,45–140,55°C), del contenido de humedad (CH, 21,27–34,73%), y del contenido de harina de calabaza (HCAL, 0,43–15,57%) sobre características fisicoquímicas y contenido de compuestos bioactivos de alimentos botana de tercera generación (3G) expandidos por microondas. Se utilizaron como ingredientes para su elaboración almidón de maíz, harinas de maíz amarillo integral y harinas de calabaza. Se utilizó un extrusor de tornillo simple, siendo aplicada la metodología de superficie de respuesta. La menor densidad aparente y el mayor índice de solubilidad en agua (ISA) e índice de absorción de agua se obtuvieron a altas TE y bajos CH. Los mayores valores de carotenoides totales y fibra dietaria (total y soluble) se presentaron a altos HCAL y TE. Además, al aumentar HCAL disminuyó el valor de L* de color, mientras que aumentó el valor de b* e ISA. Los resultados obtenidos sugieren que es posible elaborar alimentos botana 3G con características fisicoquímicas aceptables y excelente contenido de compuestos bioactivos, mejorando sus beneficios potenciales en la salud.

Palabras claves: Botanas funcionales; extrusión; botanas de tercera generación; compuestos carotenoides; fibra dietaria

Introduction

Extrusion cooking technology is a versatile and efficient process for converting raw materials into finished food products. Food extruders provide thermo-mechanical energy (shear) needed to cause physico-chemical changes of foods, implying mixing and homogenization (Anton & Luciano, 2007). Extrusion technology plays a very important role in modern industrial production of snacks, especially those produced from corn, wheat, and rice. Snack foods are mainly made from cereals, and are widely available, becoming an important part of the global diet. Among these kind of foods, third-generation (3G) snack foods have become an important part of the American diet (Ernoult, Moraru, & Kokini, 2002). This type of snack, unlike the products directly expanded, is not ready to eat when it is expelled from the extruder, in which case it is referred to as pellet. Pellet facilitates handling because a large amount of the product as pellet occupies a small storage volume (Hollingsworth, 2001). The pellet can be expanded later by various heating methods such as frying, hot-air oven, or microwave heating. This latter method has gained popularity among consumers because it is relatively cheap and easy to prepare at home and, once expanded, the final products have low oil content (Bastos-Cardoso, Zazueta-Morales, Martínez-Bustos, & Kil-Chang, 2007). In the microwave heating, the microwave energy heats the pellet by vibrational energy directed to the moisture contained within. This heating generates the superheated steam that causes the pellets to expand and form a porous structure. Maximum expansion of 3G snacks takes place at 10–12% of moisture content (MC) of the pellets (Boischot, Moraru, & Kokini, 2003). There have been investigations where microwave has been used to expand this type of snacks and some reports about 3G snacks have focused on the effect of processing on different physical and physicochemical characteristics (Gimeno, Moraru, & Kokini, 2004; Lee, Lim, Lim, & Lim, 2000). In extruded snack foods, physical parameters as bulk density (BD), expansion index, and texture have shown to be appropriate quality parameters (Chessari & Sellahewa, 2000; O'Shea, Arendt, & Gallagher, 2013). On the other hand, other studies have focused on the improvement of nutritional or nutraceutical properties of 3G snacks, by incorporating raw materials

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Effect of extrusion conditions on physicochemical characteristics and anthocyanin content of blue corn third-generation snacks

Efecto de las condiciones de extrusión sobre características fisicoquímicas y contenido de antocianinas de alimentos botana de tercera generación de maíz azul

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The aim of this study was to evaluate the effect of barrel temperature (BT, 98.8–141.2°C) and feed moisture (FM, 19.93–34.07%) as independent factors on physicochemical characteristics of microwave-expanded extruded third-generation (3G) snacks obtained from blue corn and corn starch. Single-screw laboratory extruder and a central, composite, rotatable experimental design were used. Both independent factors showed significance ($p \leq 0.01$) on most of the analyzed responses. The mathematical models showed values of $R^2_{Adj} \geq 0.76$ and p of $F_{(model)} \leq 0.001$. The optimum area of the extrusion process ranged from 120°C to 126°C for BT and from 23.8% to 25.2% for FM. In optimal conditions, the product showed an expansion index of 4.8, a penetration force of 12.42 N, a specific mechanical energy of 169.08 kJ/kg, and 71.09 mg of total anthocyanin content/kg. The developed 3G snack presented high-quality physicochemical characteristics, with the potential health benefits derived from nutraceutical characteristics (dietary fiber and anthocyanins) of the whole blue corn used.

Keywords: extrusion; blue corn; third-generation snack; anthocyanin

El objetivo de este estudio fue evaluar el efecto de la temperatura de barril BT (98,8–141,2 °C) y la humedad de alimentación FM (19,93–34,07%) como factores independientes, sobre características fisicoquímicas de botanas extrudidas, de tercera generación (3G), expandidas por microondas, obtenidas a partir de maíz azul y almidón de maíz. Se utilizó un extrusor de laboratorio de tornillo simple y un diseño experimental central compuesto, rotable. Ambos factores independientes mostraron significancia ($p \leq 0{,}01$) en la mayoría de las respuestas analizadas. Los modelos matemáticos mostraron valores de $R^2_{aj} \geq 0{,}76$ y p de $F_{(modelo)} \leq 0{,}001$. La zona óptima para el proceso de extrusión varió de 120–126 °C de BT y de 23,8–25,2% de FM. En condiciones óptimas el producto mostró un índice de expansión de 4,8, una fuerza de penetración de 12,42 N, una energía mecánica específica de 169,08 kJ/kg y 71,09 mg de contenido total de antocianina/kg. La botana 3G desarrollada presentó características físico-químicas de alta calidad, con los beneficios potenciales para la salud, derivados de las características nutracéuticas (fibra dietaria y antocianinas) del maíz azul integral utilizado.

Palabras clave: extrusión; maíz azul; botana de tercera generación; antocianina

Introduction

A snack is defined as a small, lightweight food that is easy to manipulate, ready to eat, accessible, and, most importantly, able to satisfy the appetite sensation for a moment (Hurtado, Escobar, & Estévez, 2001). Snack foods are widely consumed, regardless of social status, age, or gender. The industrial sector of snacks in Mexico is booming with an annual market value of 3419 million dollars, offering various kinds of snacks, mainly, the potato and corn (dough and tortilla) derivatives (http://inegi.gob.mx). Among the main types of snacks are the third-generation (3G) snacks, also known as intermediate snacks or pellets, which are cheap and easy to prepare at home (Hollingsworth, 2001). In the processing of 3G snacks, the dry ingredients are mixed with water (22–35%) to form a dough. The 3G snacks are prepared by extrusion, formed at low pressure to avoid expansion, and dried to a final moisture content of 10–14% to form a glassy pellet. The extrusion process consists of a 3-step temperature profile, starting with a low-temperature step at the feed zone (70–80°C), continuing with a high-temperature step at the mixing and cooking zone (90–145°C), and ending with a low-temperature step at the output die (75–95°C) (Bastos-Cardoso, Zazueta-Morales, Martínez-Bustos, & Yoon, 2007; Delgado-Nieblas et al., 2012). The 3G snacks have a long shelf life, being capable of retaining a good quality for at least one year, provided that a proper storage is given. As pellets, they require less storage space due to their less volume in relation to their size after expanding when compared with directly expanded snacks (Arias-García et al., 2007). However, they require a further expansion process, which may be done by hot oil, hot air, or microwave exposure. During this latter intensive heating step, the moisture in the pellet will start to boil and vapor bubbles are formed, which will expand the pellet. The expansion gives the snack a porous structure (Boischot, Moraru, & Kokini, 2003). Taking advantage of the greater consumer acceptance for 3G snacks, they can be used as nutrient carriers in order to offer

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Effect of infrared heating on the physicochemical properties of common bean (*Phaseolus vulgaris* L.) flour

Efecto del calentamiento infrarrojo en las propiedades fisicoquímicas de la harina de frijol común (*Phaseolus vulgaris L.*)

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The objective of the presented work was to determine the effect of infrared heating on the physicochemical characteristics of Mexican common bean flour. Variety of Pinto Villa beans were used in the present experiment. Infrared heating was fitted at 0, 10, 20 and 40 Hz. Power absorption, relative crystallinity by X-ray diffraction, proximate analysis, water absorption capacity, water absorption index, viscosity, and total, resistant and available starch methods were used to characterize the common bean flour. X-ray diffraction data showed changes in the diffraction patterns attributable to the possible formation of amylose–lipid complex. Water absorption capacity (WAC) and water absorption index (WAI), as well viscosity profiles, were affected by changes in the starch and protein content. Sample with highest power absorbed (20 Hz) show highest values of WAC and WAI and lowest value of viscosity. The content of resistant starch (RS) was highest at medium absorbed power (10 Hz).

Keywords: common beans; infrared heating; resistant starch; water absorption capacity

El objetivo del presente estudio consistió en determinar el efecto que el calentamiento infrarrojo tiene en las características fisicoquímicas de la harina del frijol mexicano común. En el presente experimento, se utilizaron frijoles de la variedad Pinto Villa. Se calibró el calentamiento infrarrojo a 0, 10, 20 y 40 Hz. Para caracterizar la harina de frijol común, se utilizaron métodos de absorción de potencia, de cristalinidad relativa a partir de difracción por rayos x, de análisis químico, de capacidad de absorción de agua, de índice de absorción de agua, de viscosidad y de almidón total, resistente y disponible. Los datos obtenidos de difracción por rayos x revelaron cambios en los patrones de difracción atribuibles a la posible formación de complejos de amilosa-lípidos. La capacidad de absorción de agua (caa) y el índice de absorción de agua (iaa), así como los perfiles de viscosidad fueron afectados por los cambios en el contenido de almidón y de proteína. La muestra con la más alta absorción de poder (20 Hz) resultó tener los valores de caa y de iaa más elevados y el valor de viscosidad más bajo. El contenido de almidón resistente (ar) fue más alto en la muestra con un poder absorbido medio (10 Hz).

Palabras clave: frijol común; calentamiento infrarrojo; almidón resistente; capacidad de absorción de agua

Introduction

Common beans are staple food for undeveloped countries. They are well known as a rich source of carbohydrates, proteins, vitamins and minerals. Of the carbohydrates, starch and nonstarch polysaccharides (dietary fibre) are the major constituents (Vargas-Torres, Osorio-Díaz, Tovar, Paredes-López, Ruales & Bello-Pérez, 2004). Based on the hydrolysis rate of starch, it is classified as rapidly digestible starch (RDS), slowly digestible starch (SDS) and resistant starch (RS) (Englyst, Kingman, & Cummings, 1992). RS is defined as the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals (Asp, 1992). The digestibility of the starch (or starchy foods) strongly depends on starch structure and on its processing (Lehmann & Robin, 2007).

Cereal starches with A-type pattern are rapidly digested (RDS), whereas tubers and high amylase starches with B-type pattern are somewhat resistant to amylolytic hydrolysis (RS) (Biliaderis, 1991). The legume starches with C-type pattern, an intermediate between A-type and B-type patterns, are slow digestible starches (SDS) (Englyst, Kingman, & Cummings, 1992). The reduced bioavailability of legume starches has been attributed to the presence of intact tissue/cell structures enclosing starch granules, high levels of amylose (30–65%), high content of viscous soluble dietary fibre components, presence of a large number of antinutrients, 'B' type crystallites and strong interactions between amylose chains (Deshpande & Cheryan, 1984; Hoover & Sosulski, 1985; Siddhuraju & Becker, 2001; Tovar, de Francisco, Bjorck, & Asp, 1991; Wursch, Dal Vedovo, & Koellreuter, 1986). Unfortunately, the difference in digestion properties between A-type cereal starch and B-type potato starch disappeared after cooking (Zhang, Venkatachalam, & Hamaker, 2006). They claim that the cooking process completely destroys the semicrystalline structure of native starch granules, with a loss of SDS and an increase of RDS. Besides these crystalline features, the physically inaccessible starch fractions also contribute to the slow digestion.

RS is classified into four types: RS type I is defined as physically inaccessible starch; type II is defined as RS granules; type III is

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Study of spray drying of the *Aloe vera* mucilage (*Aloe vera barbadensis* Miller) as a function of its rheological properties

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ABSTRACT

Spray Drying (SD) was used to obtain *Aloe vera* powder from fresh plants. The powder was reconstituted in an aqueous medium and its rheological properties, particle size distribution (PSD), thermal properties (differential scanning calorimetry, DSC), and morphology (scanning electron microscopy, SEM) were evaluated in order to find an alternative to natural gum to be used in the food industry. Rheological measurements were conducted at 25 °C in aqueous concentrations of 3 g/100 mL and 6 g/100 mL. A 2^3 factorial design was used with three central points to evaluate yield, efficiency and the rheological properties of reconstituted powders, results were compared with a liophilized (FD) sample of *A. vera* mucilage. Experimental results showed that the shear viscosity decreased with the increase of the inlet air temperature and the speed of atomization, and it increased with increasing feed flow in SD. Additionally, most powders obtained in all treatments have an average particle diameter of ~10 μm with a modal distribution (PSD). The best conditions of SD in order to obtain a good thickening agent were: 150 °C inlet temperature, 1.5 L/h feed rate and atomization speed of 275,000 rpm, and with rheological properties very close to those of the FD sample.

1. Introduction

Due to the concern and current interest of people in their health and quality of life, there has been an increasing demand for natural products, which has impelled pharmaceutical and natural products industries to focus their research on products with functional properties. A raw material that currently has potential in this field is *A. vera*, a kind of cactus from which cosmetics, pharmaceuticals and chemistry products can be obtained. *A. vera* is considered to be a potential source of gums and/or hydrocolloids (Sánchez González, Vargas, González-Martínez, Cháfer, & Chiralt, 2008). The selection of new sources of biopolymers requires a thorough understanding of the rheological properties and physicochemical characteristics of natural chemistries (García-Cruz, Rodríguez-Ramírez, Méndez-Lagunas, & Medina-Torres, 2013). These properties of the gum are sensitive to separation methods and they can be significantly altered with the drying process (Wang, Wang, Li, Xue, & Mao, 2009). It has been shown that this plant can provide nutritional components as feedstock for the production of functional products, considered the chemistry of the future (Vega, Ampuero, Díaz, & Lemus, 2005). *A. Vera* is a plant that has great range for adaptation to the environment due to its high rate of water retention, allowing it to form a dense layer of gel, which contains 99.4 g/100 g water and 0.6 g/100 g of solids, there are at least four different partially acetalized sugars in its composition that differ in the radius of the glucose and mannose (Vega, Uribe, Lemus, & Miranda, 2007). This plant has a composition of equal proportions of D-glucose and D-mannose (76 g/100 g), with 24 g/100 g of uronic acid, the juice contains 55.2 mg of polysaccharides per 100 mL of juice. The approximate total mass of polysaccharides is 788 mg/L (Rodríguez-González, Femenia, Minjares-Fuentes, & González-Laredo, 2010). Femenia, Sánchez, Simal, and Rosselló (1999) and Femenia, García-Pascual, Simal and Rosselló (2003) reported that the polysaccharides contained in the parenchyma of the *Aloe* are of

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Research Article

Influence of Commercial Saturated Monoglyceride, Mono-/Diglycerides Mixtures, Vegetable Oil, Stirring Speed, and Temperature on the Physical Properties of Organogels

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The objective of this study was to evaluate the influence of gelator, vegetable oil, stirring speed, and temperature on the physical properties of obtained organogels. They were prepared under varying independent conditions and applying a fractional experimental design. From there a rheological characterization was developed. The physical characterization also included polarized light microscopy and calorimetric analysis. Once these data were obtained, X-Ray diffraction was applied to selected samples and a microstructure lattice was confirmed. Commonly, the only conditions that affect crystallization have been analyzed (temperature, solvent, gelator, and cooling rate). We found that stirring speed is the most important parameter in the organogel preparation.

1. Introduction

Gels have been described as materials that are "easier to recognize than define" [1]. Most of the times this problem comes from industry, which develops products with a gel name, just to be attractive to consumers [2]. However, gels have been accepted as semisolid materials comprising low concentrations (<15%) of gelator molecules to form a network self-assembly that entraps the solvent (in organogels both nonpolar components), preventing flow due to surface tension [3].

Gels can be defined both from a rheological behavior and from a structural feature. In a rheological point of view, a gel is a system that does not flow and has the presence of a plateau region of storage modulus and a low tanδ (<0.1) at an angular frequency from 10^{-3} to 10^{2} rad/s. The structural definition is based on the connectivity of the system. Gel is a system consisting of molecules, particles, and chains, which are partially connected to each other in a fluid medium by crosslinks to the macroscopic dimensions. Then the loss of fluidity is the result of connectivity. Both are operational definitions and may have the possibility of exclusions [2].

Organogels have been attracting much attention in biomedical and pharmaceutical fields, where the erosion of gels in stomach and intestines is important for drug delivery [4, 5]; therefore gels erosion has been applied for this purpose [6]. As oils are safe materials and are suitable for lipophilic components [7], they are considered a good option for organogels elaboration. That is why food industry is very interested in this type of systems as a replacement of hydrogenated fats [8]. Thus, understanding organogels, definition is closely related to their characteristics and their crucial potential to develop new applications.

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Efecto del procesamiento térmico sobre la capacidad antioxidante de pinole a base de vainas de mezquite (*Prosopis laevigata*)

Thermal processing effect on the antioxidant capacity of pinole from mesquite pods (*Prosopis laevigata*)

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The objective of this study was to prepare a pinole meal made of mesquite pods (*Prosopis laevigata*) and evaluate its functional properties. A $(3)^2$ experimental design was implemented setting three drying (60, 70, 80°C) and three roasting (140, 150, 160°C) temperatures, and a control sample (pinole without thermal treatment). The product quality was evaluated by proximate analysis, including soluble proteins, electrophoretic profile, and protein digestibility; antinutrient determinations such as trypsin inhibitors, lectins, and phenolics; antioxidant activity by inhibiting the oxidation of low-density lipoproteins (LDL); and the inhibition of the angiotensin converting enzyme (ACE). The major digestibility was obtained at 60°C/160°C (74.43 $\pm$ 0.3%). The most effective reduction in trypsin inhibitors (73%), lectins (186.81 U/mg), and phenolics was obtained at higher temperatures (80°C). Pinole extracts have inhibited LDL oxidation and the thermal treatments have shown effect on inhibiting ACE activity.

Keywords: pinole; mesquite; digestibility; phenolic compounds

El objetivo de este estudio fue obtener un pinole de alta calidad funcional a base de vainas de mezquite (*Prosopis laevigata*). Se llevó a cabo un diseño factorial $(3)^2$ con tres temperaturas de secado (60, 70 y 80°C) y tres de tostado (140, 150 y 160°C) y una muestra control (pinole sin tratamientos térmicos). Se determinó la caracterización proximal, incluyendo proteína soluble, perfil electroforético, digestibilidad de proteínas; Factores antinutrivos como inhibidores de tripsina, lectinas y fenoles; Actividad antioxidante por inhibición de la oxidación de lipoproteínas de baja densidad (LDL); y Capacidad hipotensiva por la inhibición de la Enzima Convertidora de Angiotensina (ACE). La mayor digestibilidad se encontró a 60°C/160°C (74,43$\pm$0,38%). La temperatura de secado más alta (80°C) mostró la mayor disminución de inhibidores de tripsina (73%) y lectinas (186,81 U/mg). Asimismo, los fenoles disminuyeron con un incremento de temperatura (secado y tostado). Los extractos de pinole disminuyeron la oxidación de las LDL y los tratamientos térmicos mostraron efecto sobre la inhibición de la actividad de la ACE.

Palabras clave: pinole; mezquite; digestibilidad; compuestos fenólicos

Introducción

El género *Prosopis*, al cual pertenece el mezquite es una planta silvestre de la familia *Leguminosae* (Fabaceae), subfamilia *Mimosoideae* es nativa de Asia, África y América, comprende 44 especies distribuidas en las regiones áridas y semiáridas (Burkart, 1976). En México se encuentra principalmente en la vertiente del pacífico desde Michoacán hasta Oaxaca y en la del Golfo de México en Nuevo León, Tamaulipas, y el norte de Veracruz y en las regiones centrales de altura del país hasta los 2,300 m (Gómez, Signoret, & Abuin, 1970). El mezquite produce grandes cantidades de vainas indehiscentes. En promedio las vainas pesan 12 g, la cuales están formadas por tres partes principales: mesocarpio que constituye 56%, endocarpio 35% y semilla 9%. Los frutos de *Prosopis spp*. Presentan un alto contenido de azúcar (13–50%), fibra (27–32%), proteína (8,1%), cenizas (3,6%), y en menor cantidad compuestos fenólicos (1,2%) (Becker, Sayre, & Saunders, 1984; Bravo, Grados, & Saura-Calixto, 1994; Grados, Bravo, & Saura-Calixto, 1993).Las vainas de mezquite (*Prosopis spp*.) jugaron un rol importante en el desierto de Sonora, las tribus indias elaboraban harina y pasta con la pulpa de las vainas secas o tostadas (Simpson, 1977). Para los rumiantes las vainas y hojas son una fuente económica importante de alimentación (Obeidat, Abdullah, & Al-Lataifeh, 2008). Como alimento humano se consumen las vainas en forma de fruta fresca, fruta conservada en su propio jugo dulce, pinole de mezquite, queso de mezquite, piloncillo, atole, harinas o como bebidas fermentadas. La vaina seca es triturada, lo cual da una harina que puede ser mezclada con un poco de agua y consumida inmediatamente (Galindo & García, 1986). El jugo extraído del fruto fresco con agua hervida puede ser añadido a la harina de maíz para formar avenate como bebida. La fermentación de los azúcares del fruto produce bebidas alcohólicas como: aloja, añapa y chicha (Galindo & García, 1986; Odibo, Ezeaku, & Ogbo, 2008). Las semillas son fermentadas para producir condimentos los cuales son consumidos por encima de 1.5 millones de gente (Odibo et al., 2008). La goma tiene una consistencia suave y sabor dulce, la cual es usada como dulce para niños.

En el Norte de Argentina, la harina hecha de la pulpa de mezquite es conocida como *pataý*, el cual se sigue consumiendo todavía (Escobar, Estévez, Fuentes, & Venegas,

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Microencapsulation by spray drying of gallic acid with nopal mucilage (*Opuntia ficus indica*)

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ABSTRACT

The spray-drying process has been previously used to encapsulate food ingredients such as antioxidants. Thus the objective of this work was to produce microcapsules of gallic acid, a phenolic compound that acts as antioxidant, by spray drying with an aqueous extract of nopal mucilage (*Ofi*), which acted as an encapsulating agent. The rheological response and the particle size distribution of the final solutions containing gallic acid at concentrations of 6 g/100 mL were characterized along with the control sample, no gallic acid added, to elucidate the degree of encapsulation. The drying parameters to prepare the microcapsules with extract of nopal mucilage were: inlet air temperature (130 and 170 °C) and speed atomization (14,000 and 20,000 rpm). The rehydrated biopolymer showed a non-Newtonian pseudoplastic behavior. The Cross Model was used to model the rheological data. Values for "m" varied between 0.55 and 0.85, and for "time characteristic, λ", the range was between 0.0071 and 0.021 s. The mechanical spectra showed that the sample with gallic acid was stable long term (>2 days) and presented a bimodal particle size distribution. This study demonstrated the effectiveness of nopal mucilage when utilized as wall biomaterial in microencapsulation of gallic acid by the spray-drying process.

1. Introduction

Polyphenols are chemical compounds or phytochemicals with diverse biological activities due to their antioxidant capacity. Ingestion of polyphenol-rich foods should be beneficial to human health as factors associated with cardiac mortality in developed countries with particular reference to the consumption of wine (St. Leger, Cochrane, & Moore, 1979). Wine has antimicrobial and antifungal activity and may play a role in the etiology of migraine. Red wine may even protect against the common cold. Wine contains polyphenols from the flavonoid type, mostly as grape tannins (about 35 g/100 g) and anthocyanin pigments (about 20 g/100 g), not only present mostly in red rather than in white grapes (Takkouche et al., 2002), but also non-flavonoid phenolics such as stilbenes and gallic acid. Gallic acid (acid 3,4,5-tri-hydroxy-benzoic) and its derivatives are considered natural antioxidants and their effects and uses have been widely reported (Cho, Kim, Ahn, & Je, 2011; Pasanphan & Chirachanchai, 2008; Negi et al., 2005). Stabilization and application of polyphenols in foods and nutraceutical formulations can be improved by microencapsulation technologies (Sáenz, Tapia, Chávez, & Robert, 2009). Microencapsulation allows protection of bioactive compounds; *i.e.*, an active material (nucleus) is embedded in a polymer matrix (encapsulating agent or wall material) to act as a protective barrier against external or environmental factors (Ahmed, Akter, Lee, & Eun, 2010; Borgogna, Bellich, Zorzin, Lapasin, & Cesàro, 2010; Sáenz et al., 2009).

Spray drying is a common technique for producing encapsulated food materials (Sáenz et al., 2009). Good microencapsulation efficiency during spray drying is achieved when the maximum amount of core material is encapsulated inside the powder particles, succeeding in microcapsule stability, volatile losses prevention, and product shelf-life extension (Seid, Elham, Bhesh, & Yinghe, 2008). In spray drying, the operating conditions and the dryer design used depend on the characteristics of the material to be dried and the desired powder specifications (León Martínez, Méndez, & Rodríguez, 2010). Studying the effect of operating parameters

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Physicochemical properties and antioxidant capacity of oak (*Quercus resinosa*) leaf infusions encapsulated by spray-drying

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ABSTRACT

The effect of two wall materials and two feed flow rates on the physical and antioxidant properties of *Quercus resinosa* leaf infusion microencapsulated by spray-drying is reported. Dispersions with lyophilized *Q. resinosa* infusion and wall material (k-carrageenan and maltodextrin [10 DE]) were prepared. Samples were fed at rate flows of 1.6 and 1.7 L/h. Encapsulation yield, total phenolic content, DPPH test, deoxy-D-ribose assayt, rheological and SEM evaluations were made. The highest yield and DPPH scavenging activity were obtained at 100% maltodextrin and 1.7 L/h. Higher polyphenolic retention was observed in blends of carrageenan/maltodextrin (1.6 and 1.7 L/h) and maltodextrin (1.6 L/h). The highest inhibition of deoxy-D-ribose oxidation was found at blends of carrageenan/maltodextrin (1.7 L/h). Dispersions showed pseudoplastic behavior and properties as liquid-like materials. Microcapsules showed particle sizes between 5 and 35 μm. The best condition for encapsulation of *Q. resinosa* infusions was suggested as 100% maltodextrin at 1.7 L/h.

1. Introduction

Quercus resinosa is a deciduous tree belonging to the family *Fagaceae* and is found in the mixed pine-oak forests in Northern Mexico. The bark, leaf and galls have been studied by several researchers in function of their antioxidant capacity (Rivas-Arreola et al., 2011; Rocha-Guzman et al., 2009). Rocha-Guzman et al. (2012) identified several polyphenol compounds in *Q. resinosa* infusions by HPLC including gallic acid, syringic acid, epigallocatechin gallate. Based in the scientific evidence, it is clear that *Q. resinosa* infusions have antioxidant properties related with its phenolic content.

Unfortunately, phenolic compounds are influenced by several factors as oxygen, temperature and processing. Moreover, the antioxidant capacity could be affected with

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Effect of extrusion cooking on the antioxidant activity of extruded half product snacks made of yellow corn and pumpkin flours

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Characterization and Optimization of Extrusion Cooking for the Manufacture of Third-Generation Snacks with Winter Squash (*Cucurbita moschata* D.) Flour

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ABSTRACT

The aim of this work was to study the effects of barrel temperature (BT, 93.5–140.5°C), feed moisture (FM, 21.3–34.7%), and winter squash flour content (SFC, 0.43–15.6%) on physicochemical properties of microwave-expanded third-generation snack foods obtained by extrusion. Physicochemical properties used for optimization were expansion index (EI), penetration force (PF), specific mechanical energy (SME), and total color difference (ΔE). Response surface methodology was used for the analysis of data. The highest values of EI and lowest values of PF were found at high BT and low FM. The lowest values of SME were obtained at high levels of FM throughout the range of BT and SFC, whereas the highest values of ΔE were obtained at high SFC and low FM. Increasing levels of SFC increased ΔE values, whereas EI and SME values decreased. The best processing conditions (EI > 6.0, PF < 9.5 N, SME < 172 kJ/kg, and ΔE < 18) were found in the range of BT, 122–141°C; FM, 24.7–29.5%; and SFC, 0–10.9%. Under optimal process conditions, the retention of total carotenoids was higher than 60%. It is possible to manufacture third-generation snack foods with good physicochemical properties, which could bring a health benefit because of the presence of carotenoids and dietary fiber in winter squash flour.

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Extrusion has become a popular food-processing technique especially in the cereal and snack food industry. It is considered to be a high-temperature–short-time processing method and is capable of preserving desirable food components and of destroying microorganisms (White et al 2010). One of the benefits of extrusion is to increase the variety of foods in the diet by producing a range of products with different shapes, colors, flavors, and textures from basic ingredients. The physical characteristics of extrudates are governed by the properties of feed materials and extrusion-cooking parameters such as moisture content, die diameter, temperature, screw speed, and feed rate (Harper 1989; Ali et al 1996). Third-generation snacks, also referred to as "half products" or pellets, provide an alternative to fully prepared puffed snack foods. These products are extrusion cooked, formed at low pressure to prevent expansion, and then dried to a final moisture content of about 10% to form a glassy pellet (Sunderland 1996). Being a dry material, properly stored pellets retain their quality without deterioration for at least a year after production; in addition, pellets require less storage space because their unexpanded volume is lower than their expanded size (Arias-García et al 2007). Starch is the major component of the cereal flours used in the manufacture of expanded extrudates. Most extruded foods are actually made out of complex formulations that include starch, protein, fat, sugar, and fiber. All these ingredients produce different effects on extrudate expansion (Moraru and Kokini 2003). Maize grits are the main raw material for the production of expanded snacks. To nutritionally strengthen snack foods, raw materials providing substances with human health benefits have been sought. Yellow corn contains significant amounts of lutein, zeaxanthin, and other carotenoids; it is also a popular vegetable in the American diet (Scott and Eldridge 2004). Studies have also shown that dietary intakes of lutein and zeaxanthin can reduce the risks of cataracts and age-related macular degeneration, which is the leading cause of blindness among the elderly (Landrum et al 1996, 1997). Squash is a species of *Cucurbitaceae* whose fruit has yellow to orange-red flesh. The flesh of squashes is known to be among the richest sources of carotenoids (Arima and Rodriguez-Amaya 1990), fiber, and some minerals, such as potassium, manganese, and magnesium. Delgado-Nieblas et al (2007) used winter squash (*Cucurbita moschata* D.) cv. Cehualca to produce a precooked flour by drying and found water adsorption values greater than 25 g water/g dry solids in the flours. The squash fruit provides provitamin A in the form of α-carotene, β-carotene, and lutein (Ortiz-Grisales et al 2008). Jacobo-Valenzuela et al (2008) found a total carotenoid content in winter squash cultivar Cehualca of 346 μg/g db. A variety of research indicates the beneficial influence on human health of a diet rich in β-carotene. For this reason, studies have been undertaken to process winter squash with a high carotenoid content into ready-to-eat snacks (Konopackaa et al 2010). The objective of this work was to evaluate the effects of barrel temperature (BT), feed moisture (FM), and winter squash flour content (SFC) on physicochemical properties of third-generation snack foods obtained by extrusion and expanded by microwave.

MATERIALS AND METHODS

Raw Materials

Commercial maize starch (IMSA, S.A. de C.V., Mexico), yellow corn (*Zea mays* L.) flour, and Cehualca winter squash flour were used for formulating blends. Yellow corn grains were obtained from Angostura valley, Sinaloa, Mexico, and winter squash was acquired from a market in Culiacan, Sinaloa, Mexico. Squash flour was prepared from the pulp of the squashes, which were cut into 2 mm slices and blanched at 95 ± 2°C for 2 min. Slices were dried with a forced hot air dryer (1.45 m/sec, temperature of 72°C for 110 min) and milled to a particle size less than 250 μm (passed mesh 60). These materials were mixed at a 1:1 ratio of yellow corn flour and corn starch, whereas the concentration of winter squash flour was varied according to the experimental design from 0.4 to 15.6%. These levels were chosen because, in a preliminary study that used concentrations higher than 16% of winter squash flour, snacks showed low values of expansion and high values of penetration force (PF), which are undesirable characteristics for third-generation snacks.

Chemical Composition

Official methods of AOAC (1999) were used to analyze moisture content (925.09), ash (923.03), protein (979.09), fiber

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REGULAR ARTICLE

EFFECT OF THE ADDITION OF COMMON BEAN FLOUR ON THE COOKING QUALITY AND ANTIOXIDANT CHARACTERISTICS OF SPAGHETTI

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ABSTRACT

Pasta is a nutritionally unbalanced food, due to its low fat and fiber and low value of its protein. It is considered an adequate vehicle for food supplementation with minerals, proteins and other healthy components such as bioactive compounds present in common beans. The effect of composite pasta (wheat – common bean; 30 % w/w) on the cooking quality (optimal cooking time, cooking loss, weight loss, firmness, color), total phenolic content, antioxidant capacity by DPPH and ORAC assays and phenolic acid profile was investigated. According to the quality parameters, pasta added with bean flour was less hard with respect to the pasta made from durum wheat. The total phenolic content and antioxidant capacity by DPPH and ORAC assays were higher in the pasta with common bean flour than in the pasta control. Also, more phenolic acids were identified in cooked pasta containing common bean flour as analyzed by HPLC.